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ABSTRACT

This environmental unit is one of a series designed for integration within an existing curriculum. The units are self-contained and require minimal teacher preparation. The philosophy behind the units is based on an experience-oriented process that encourages self-paced independent student work. This particular unit is an introduction to the techniques of sampling. Using button and bean populations, students learn various ways of sampling. Next, they learn to use this data by constructing simple graphs based on their statistical analysis of the samples. At the end of the unit are eight additional activities designed for independent study. Students can investigate variations within human and plant populations and statistically study their frequency through random sampling techniques. This unit is designed for students in grades 3-9. Each activity contains a list of materials, directions, and discussion questions to aid the teacher. (MA)

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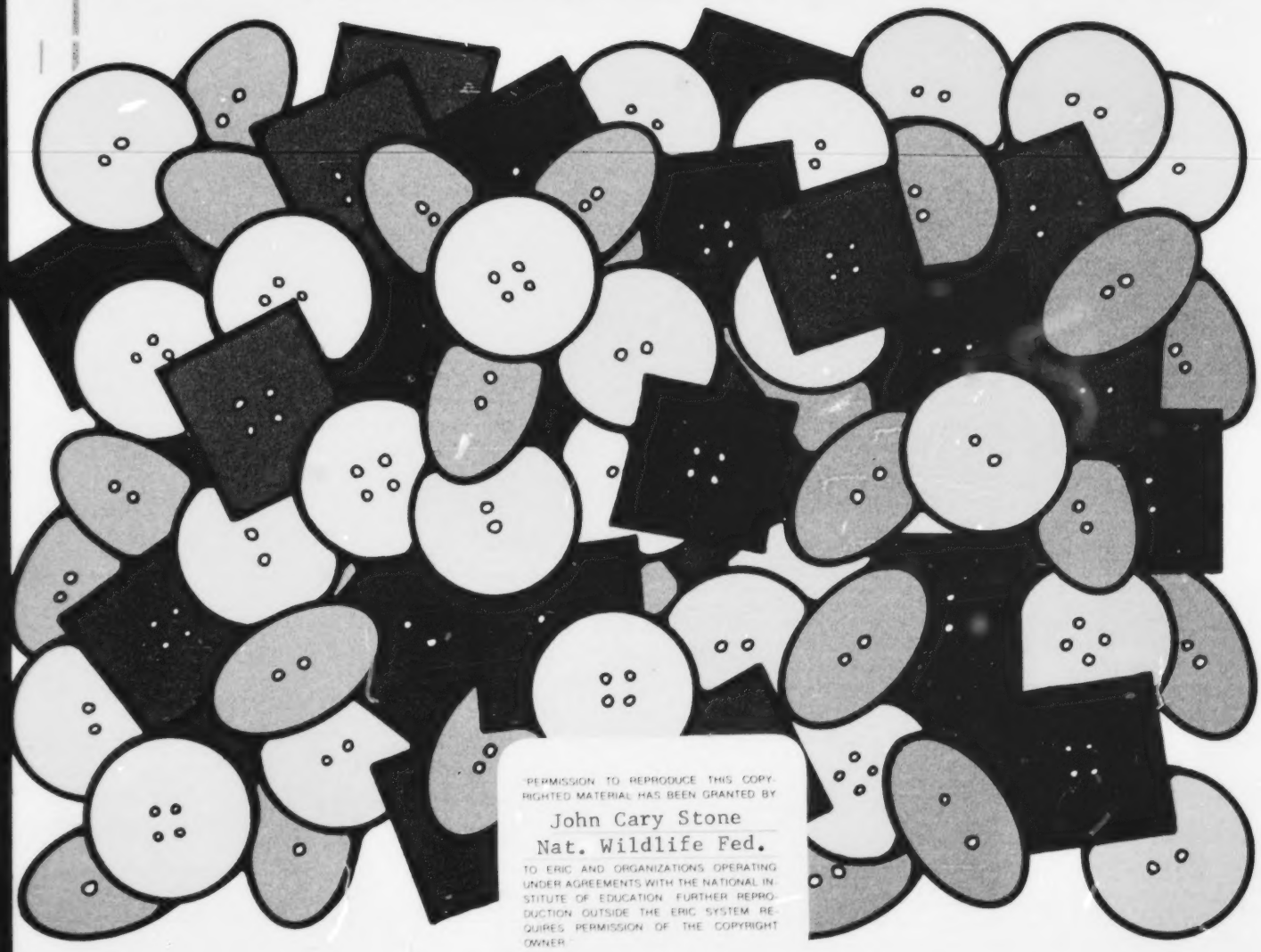
A Teacher's Preparation for

Sampling Button Populations

An Environmental Investigation into Statistics in the Classroom



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NATIONAL WILDLIFE FEDERATION

written by

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.

THE ENVIRONMENTAL UNITS

This is one of a group of Environmental Units written by the Environmental Science Center and published by the National Wildlife Federation.

In both theory and practice education is the essential base for long-range local, regional and national programs to improve and maintain the quality of environment necessary for man's welfare and survival. Citizens must be aware of ecological relationships in order to recognize, appreciate and fulfill constructive roles in society. This awareness should be launched through the existing educational process—in classroom and related school activities. No special courses on ecology can replace the need to integrate ecological learning throughout the existing curricula of our school systems. Furthermore, the life-styles and value-systems necessary for rational environmental decisions can best be acquired through repeated exposure to ecological learning which pervades the total educational experience.

It was with these thoughts that we developed these curriculum materials. They were designed for the classroom teacher to use with a minimal amount of preparation. They are meant to be part of the existing curriculum—to complement and enhance what students are already experiencing. Each unit is complete in itself, containing easy-to-follow descriptions of objectives and methods, as well as lists of simple materials.

The underlying philosophy throughout these units is that learning about the environment is not a memorization process, but rather an experience-oriented, experiment-observation-conclusion sort of learning. We are confident that students at all levels will arrive at intelligent ecological conclusions if given the proper opportunities to do so, and if not forced into "right" answers and precisely "accurate" names for their observations. If followed in principle by the teacher, these units will result in meaningful environmental education.

In the process of development, these units have been used and tested by classroom teachers, after which they have undergone evaluations, revisions and adaptations. Further constructive comments from classroom teachers are encouraged in the hope that we may make even more improvements.

A list of units in this group appears on the inside back cover.

About the National Wildlife Federation—1412 Sixteenth Street, N.W., Washington, D.C. 20036

Founded in 1936, the National Wildlife Federation has the largest membership of any conservation organization in the world and has affiliated groups in each of the 50 states, Guam, and the Virgin Islands. It is a non-profit, non-governmental organization devoted to the improvement of the environment and proper use of all natural resources. NWF distributes almost one million copies of free and inexpensive educational materials each year to youngsters, educators and concerned citizens. Educational activities are financed through contributions for Wildlife Conservation Stamps.

About the Environmental Science Center—5400 Glenwood Avenue, Minneapolis, Minnesota 55422

The Environmental Science Center, established in 1967 under Title III of the Elementary and Secondary Education Act is now the environmental education unit of the Minnesota Environmental Sciences Foundation, Inc. The Center works toward the establishment of environmental equilibrium through education—education in a fashion that will develop a conscience which guides man in making rational judgments regarding the environmental consequences of his actions. To this end the Environmental Science Center is continuing to develop and test a wide variety of instructional materials and programs for adults who work with youngsters.

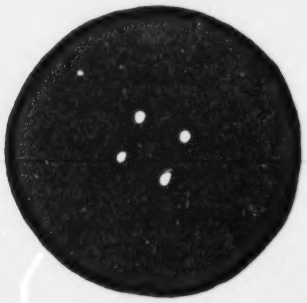
Sampling Button Populations

An Environmental Investigation

BY

NATIONAL WILDLIFE FEDERATION

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.



Design and Illustrations by

JAN BLYLER

A sizeable portion of environmental study is concerned with statistics—making sample tests and sample observations. A practical goal, then, would be to get the children interested in the workings of statistics at an early age. **Sampling Button Populations** attempts just that. It introduces students to the nature of statistics without going into all of the terminology involved. The activities help initiate a general understanding of the concepts, along with the factors which influence statistical data.

The unit comes as a result of outdoor studies which were conducted with children. In many of these studies, the students needed to take samples in order to determine soil acidity, soil moisture, density of a vegetable type, and so forth. Then they attempted to draw some conclusions. It became evident, though, that many children had little understanding of the factors which should have influenced their results. In one study, for example, they concluded from one small sample that the soil in a large area was very moist.

The basic concept of **sampling** and an awareness of the kinds of generalizations which could and could not be drawn from such samples, had not been grasped.

In order to gain an understanding of the workings of ecology, then, young people should gain an understanding of what sampling and sampling procedures are all about. We hope these activities will help provide this understanding.

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INTRODUCTION

Since statistics are the result of sampling, this unit begins with sample-taking. The children will take samples of a population—in this case, a population made up of different proportions of two kinds of beans in a bag. Then, each student will return his sample to the bag. The class will count the number of beans and determine the proportion of one kind of bean to another. The composition of the individual samples will be found to resemble the composition of the large bean bag.

In the second section the students will sample button populations which are made up of different kinds of buttons in varying proportions. After taking these samples, the students will graph their results and compare their random sample findings with the actual proportions used in preparing the button bags.

At the end of this unit, some independent investigations are provided to help the students use some of the basic statistical skills which they've acquired. The students will look more closely at problems such as sample size, number of samples taken, and random sampling.

After going through the activities of this unit, students should have a better understanding of what it means to take a sample out of a larger population, and some of the techniques which are involved. These activities should help students later on in a wide range of environmental investigations, but they should also be fun to do and educational in themselves.

MATERIALS

buttons (five different types)
plastic bags
beans
pill cups
dixie cups
graph paper
pencils
crayons
paper
glue
poster board
ribbon or rubber bands

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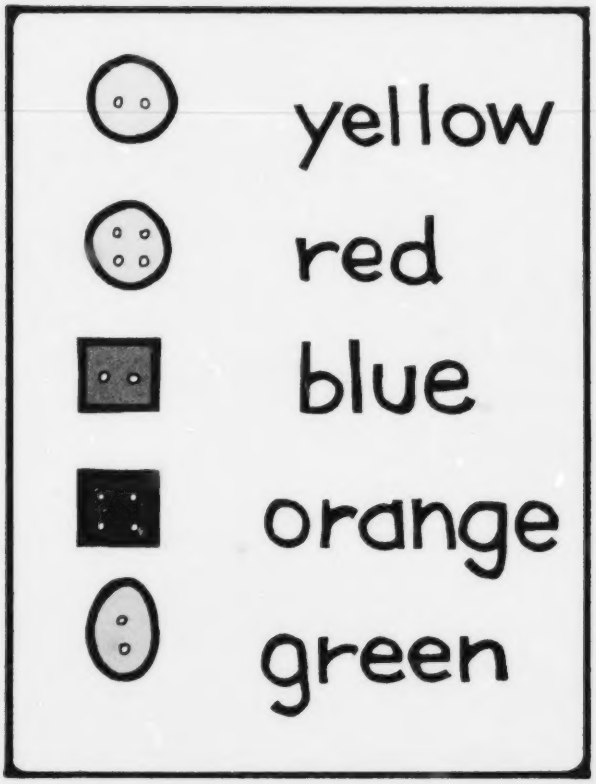
Sampling Button Populations

Preparing The Populations

I. Preparing a Button Population

MATERIALS

buttons (five different types)
plastic bags
ribbon or rubber bands



You will need to have four cups each of five types of buttons. All five types of buttons should be about the same size. Make sure all the buttons within each of the five types are the same shape and, if possible, the same color. For example, you might have four cups of round yellow buttons with two holes each; four cups of round red buttons with four holes each; four cups of blue square buttons with two holes each; four cups of orange square buttons with four holes each; and four cups of green oval buttons. You should be able to get this number of buttons at a reasonable price from a remnants store. For means of comparison, 500 shirt buttons is equal to approximately one cup. You will also need six plastic bags of a size which can conveniently hold two to four cups of buttons.

You will want to prepare three sets of mixtures, labeling each bag by set number. Each set will have two bags and both bags in each set will be made up of the same proportions. Prepare the bags like this:

Set I
Bags A_1 & A_2
Into **each** bag put the following amounts:

- ¼ cup
- ¾ cup
- 1¼ cup
- ½ cup
- ½ cup

Set II
Bags B_1 & B_2
Into **each** bag put the following amounts:

- ¾ cup
- ¾ cup
- ½ cup
- 1¼ cup
- ¾ cup

Set III
Bags C_1 & C_2
Into **each** bag put the following amounts:

- 1 cup
- ½ cup
- ¼ cup
- ¼ cup
- ¾ cup

Tie the bags shut with bright ribbon or rubber bands.

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II. Preparing the Bean Bag

MATERIALS
white beans
brown beans
bags

A. Buy one bag of white beans and three bags of brown beans (all bags and beans of the same respective size).
B. Mix the bags of beans together in another large bag. One quarter of the bag will be white beans, and three quarters will be brown beans.

Taking Samples

I. Sampling the Bean Bag

A. Mix the bean bag well and have each child take a few beans from the bag (15 to 20 or "a small handful").
B. Have each member of the class separate his beans into two piles according to color. (One brown pile, one white pile.)

ASK THE CHILDREN:

WHAT IS THE COLOR OF THE MOST NUMBER OF BEANS IN THE LARGE BAG?
WHY DO YOU THINK SO?

C. Break the class into groups of four students each and have the groups pool their bean samples together. They should make two rows of their combined beans, one white row and one brown row. (The total beans for each group should equal about 10% of the bean population that was in the bean bag in the beginning.)
D. Put these figures on the board while the children work:
   1. three white and one brown
   2. two white and two brown
   3. one white and three brown
   4. four brown
   5. four white
E. After the groups have completed their two rows of beans, ask them to predict which of the above five statements would most likely come about if they were to take beans from the bag with their eyes closed.

   Looking at the relative heights of the two columns the students made with their beans, they should see the brown column is about three times as long as the white, and should therefore choose Number 3.
F. Have the children put their beans back in the bag, mix the bag well, and choose four beans with their eyes closed. Record the number of children having a given combination next to the description of that combination on the board, and discuss the results. Do these results seem to be what the students expected?

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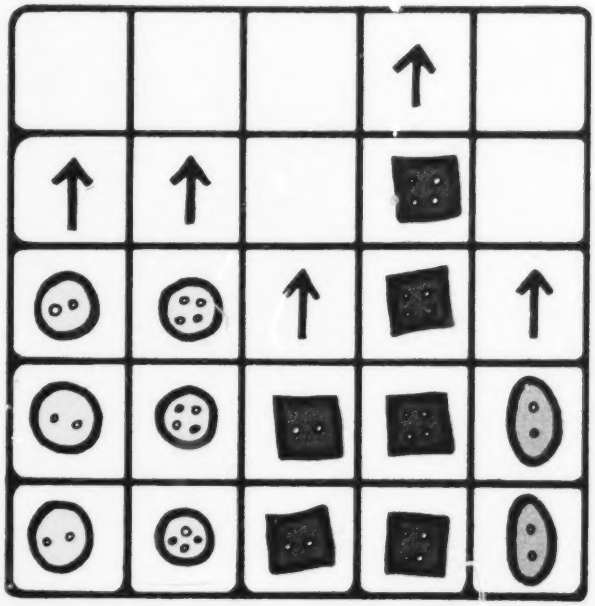
G. Divide the bag of beans among the students and have them count the total number of white beans and the total number of brown beans. They should calculate exactly how many browns there are for each white bean by dividing the number of browns by the number of whites. Their result should be approximately three browns for each white. Discuss this in terms of their findings when each student drew four beans at random **(Part F.)**



II. Sampling the Button Bag

MATERIALS

buttons	***pencils***
dixie cups	***crayons***
½-inch graph paper	***paper***

A. Divide the class into six equal groups (or as equal as possible).

B. Give each group **one** bag of buttons.

C. Have each **group** divide in half, making two teams. Thus if you have 24 students in your class, you will have 6 groups of 2 teams each. In this instance, each team would have 2 students.

D. Give each **team** a dixie cup to use for sampling (a larger sampling container might be used if your buttons are large). Each team's sample should be about 10% of the total population.

E. Give each team several sheets of half-inch graph paper. (You may have to make your own size if the largest button is bigger than ½ inch).

F. Have one or two children mix the bag thoroughly (without opening it) by shaking or kneading it (shaking alone tends to sift any small, thin buttons from the others, so ask them to use other methods of mixing also).

G. Each team should take one dixie cup of buttons as a sample. (Remember, two teams are sampling one bag.)

H. Graph the buttons from the dixie cup by laying them in rows on the graph paper. (They may have to tape several sheets of graph paper together.)

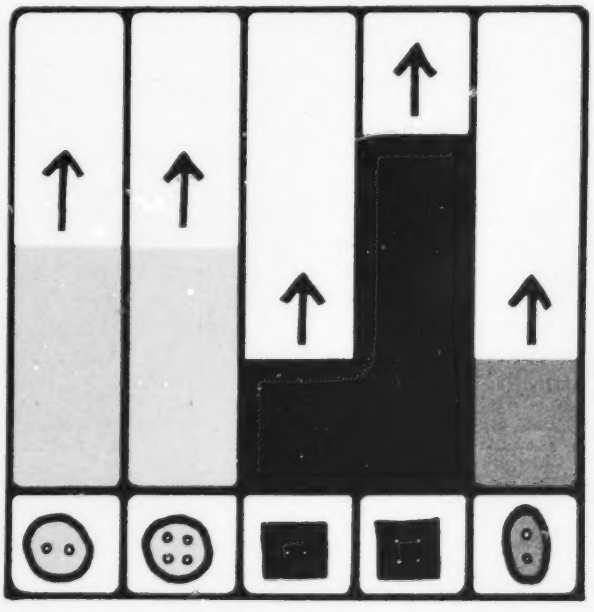
I. Have the teams from each group compare their graphs.

FOR DISCUSSION:

Are the graphs that were made from samples of the same bag similar at all? Do they have the same longest columns? The same shortest columns?

If they are similar, why are they similar? (When you eat a piece of cake, do you think another piece will taste similar to the piece you just ate? Why?)

If the students do not think their graphs are similar, have each of the two teams mix the bags and graph a second sample. Remember, ***graphs of the samples will not be exactly alike, just similar.***



J. Have the teams make a permanent record of their graph by coloring in the columns of buttons, and gluing a button to the base of the column that represents it. *Have them return the buttons to the bag.* Each permanent graph will be used in the next activity.

K. The class should now try to discover which **model graph** is similar to the individual team graphs. (See the back of the book, p. 13, for instructions on preparing the **model graphs**.)

1. **Visual Investigation**

- Hang the three **model graphs** at the front of the room.
- Ask each team to take out the sample graph it prepared earlier in "Sampling the Button Bag." Have each group of two teams try to determine which **model graph** is the most similar to the sample graphs they made. Remember that each group was made up of two teams and each team made a sample graph. The graphs made by the two teams of a single group will not be *exactly* the same but they will be *similar* to each other. Each group, then, will be looking at its own two similar graphs, and comparing these two to the three **model graphs** which you have made. The students should try to figure out which one of the three **model graphs** looks the most like the two graphs that their group made.
- When the students have picked the appropriate **model,** have them take a second sample with the dixie cup and graph that sample also. Ask if it is similar to their first sample graph. Is it more or less similar to the **model graph** they chose? Would they still choose the same **model graph** as the one which is the most similar to their own graph after this second sample has been taken? Have them make a permanent graph of the second sample as they did in **Part J.**

  If the students do not want to change their choice of **model** after taking a second sample, this will reinforce their choice of the representative **model graph.**

  If any group decides to choose a different **model graph** after this second sample, have them graph a third sample. Have them keep taking samples until they have positively decided on one representative **model graph.** It would be best for them to make permanent graphs of all their samples along the way.

2. **Numerical Investigation**

- Show the students how to find the **proportions** of buttons in their sample. The following method is a suggestion.

  Using the graph of the sample which they have decided most closely resembles one of the **model graphs,** have the students cut a strip of paper the same length as the shortest column on that graph. They should hold this strip against each column of buttons and write below the column the number of times that strip fits on the column. (Use a **model graph** to demonstrate.)

On the following page is an example of a graph which a student might make; the shortest strip would be ten squares long. The rest of the proportions would be as indicated below each column. From his graph the student can see that his sample contains one half as many round red buttons with four holes as it contains yellow round ones with two holes.

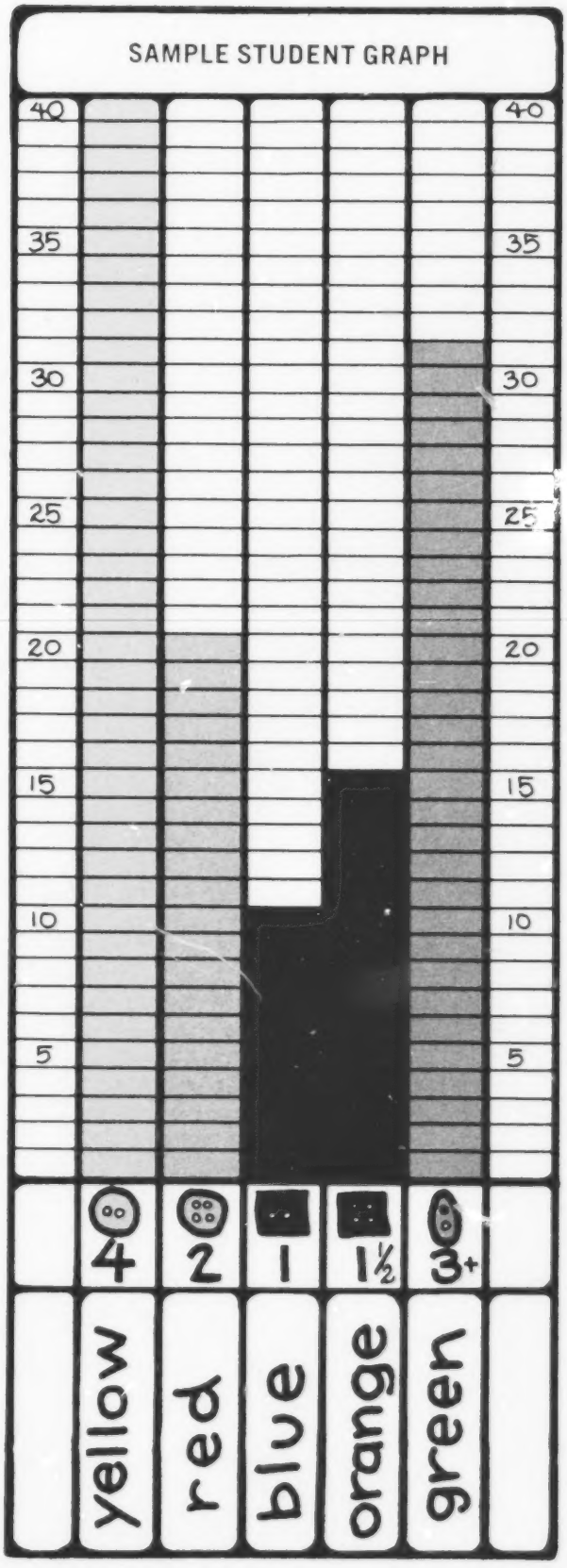
The students should compare the number below each of their columns with the number below that column on their chosen **model graph.** Did the numbers come close to being the same?

Independent Investigations

So far, the class has gained some feeling for sampling. In the back of the book we have included some Individual Investigations which can be duplicated and given to the students. The goal of these investigations which follow is to develop an understanding of the factors which influence the validity of a sample. These activities will refine sampling procedures and expand the students' grasp of their workings. Investigation #1 introduces the idea that the **size of the sample** taken must be appropriate for the size of the population. Investigation #2 deals with the **number of samples** taken and the influence of the number of samples on the sample's validity. Investigation #3 has the students compare the graph they get when the buttons are mixed well with the graph they get when the buttons are not mixed well. This introduces the idea of **random sampling** of a population.

We suggest that three or four copies of each investigation be mimeographed, glued to individual pieces of poster board, and given to the teams to read through. They should then be allowed to choose and do any of the investigations they wish. They might design their own investigation. The investigations could be conducted by the class as a whole or by small groups of students. Let the students decide how they'd like these to be done.

Display the **model graphs** throughout these investigations.



The Back of the Book

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c. Independent Investigations

Note: In investigations #1, #2, #3, and #5, tops from liquid soap bottles and pill cups are used for taking samples. If the buttons you are using are larger than shirt buttons, you will want to use slightly larger sampling devices.

INVESTIGATION #1

In the group activities which you have already done, you took samples, made graphs, and then decided which **model graph** your own graphs most closely resembled. Can you get a graph which is similar to the **model graph** by using sampling containers of sizes other than the dixie cup?

MATERIALS

the button bag you used in the team investigations
screw cap from liquid soap bottle
pill cup
3 oz. dixie cup
graph paper
crayons

PROCEDURE

1. Mix the bag well.
2. Take a sample with the **soap cap.**
3. Graph the sample.
4. Make a permanent graph using crayons.
5. Put the buttons back in the bag.
6. Mix the bag well.
7. Take a sample with the **pill cup.**
8. Graph the sample.
9. Make a permanent graph using crayons.
10. Put the buttons back in the bag.
11. Mix the bag well.
12. Take a sample with the **dixie cup.**
13. Graph the sample.
14. Make a permanent graph using crayons.
15. Put the buttons back in the bag.
16. Mix the bag well.
17. Repeat any of the steps if you aren't sure of the results.
18. Write a short report telling how the size of the sample affected your results. Refer to your **model graph** and the graphs you made during this present investigation.

INVESTIGATION #2

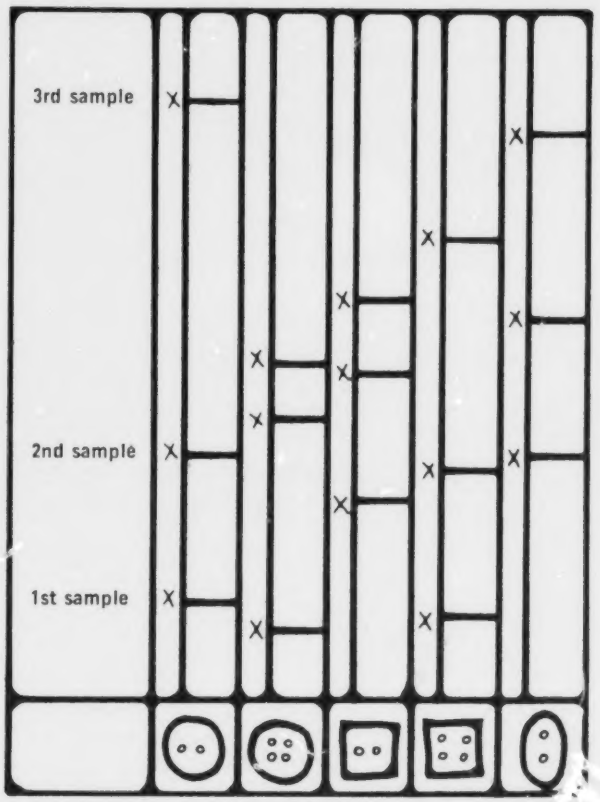
Does the **number** of samples taken have any effect on your results?

MATERIALS

screw caps from liquid soap bottles
one of the six button bags
graph paper
crayons

PROCEDURE

1. Mix the bag well.
2. Take a **sample** with the screw cap.
3. Graph the sample.
4. Make a permanent graph and return the buttons to the bag.
5. Place an "x" beside the top of each column on your graph paper.
6. Compare this graph to the **model graph** you chose earlier. Is it similar? Does it seem more similar to one of the other **model graphs?**
7. Mix the bag well.
8. Take a **second sample** with the screw cap.
9. Record this second sample on top of the first one on the graph.
10. Make it permanent by coloring it. Using a different color for the second sample will probably make the graph clearer. Return the buttons to the bag.
11. Place an "x" beside the top of each column on your graph paper.
12. Compare this graph to the **model graph** you chose earlier. Is it similar? Does it seem more similar to one of the other **model graphs?**
13. Repeat procedure 7 through 12 for a **third sample.** The following graph shows how the "x's" are placed on the graph.



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14. Write a short report telling how you feel the number of samples affected the results. Include in your report the graph you made during this investigation.

INVESTIGATION #3

During your class sampling, you were very careful to mix the buttons before taking a sample. This is called **random sampling** because no spot has any different mixture of buttons than another spot.

Would the graph be much different if the buttons were not mixed well?

MATERIALS

one of the six button bags
- *buttons of a type different from those in your bag (one cup)*

pill cup

PROCEDURE

1. Mix the button bag well.
2. Pour the cup of new buttons into the bag. Do not mix!
3. Take a sample with the pill cup.
4. Graph the sample and make a permanent graph with crayons.
5. Label the graph "unmixed" and dump the buttons back into the bag.
6. Mix the button bag well.
7. Take a sample with the pill cup.
8. Graph the sample and make a permanent graph with crayons.
9. Which graph do you think gives the most accurate picture of the number of new buttons?
10. Take several more samples to verify your choice.
11. Write a short report on your conclusions about **random sampling.** Include all graphs made during this investigation.

INVESTIGATION #4

By sampling the people in your school, can you determine about how many right-handed people there are for every left-handed person?

MATERIALS

graph paper
crayons
census forms, sample forms (ask your teacher for copies)

PROCEDURE

1. Ask the office how many children are in your school. For this number of people, how many people do you think would make a good sample size? How many people will you ask about handedness?
2. Decide **where** you will ask these people about their handedness (in the lunchroom, at the drinking fountain, on the playground).
3. Ask your teacher for the "sample of left-handed and right-handed students" form.
4. Get your teacher's okay before starting to sample.
5. Take your sample by handing the form to each student you want to sample and having that student fill it in.
6. Graph the results when all the forms have been returned.
7. Check your results by taking a census (a complete count of left and right handed students).
   - Get the form for "census of left-handed and right-handed students."
   - Go to each classroom and fill in a census form. (Get the teacher's approval first.)
   - Does this information agree with the conclusions you got when you took just a sample?
8. If the census results are not similar to the sampling results, try to improve the way you sampled. Did you take enough samples?

INVESTIGATION #5

During your sampling, you were very careful to mix the buttons before taking a sample. This is called **random sampling** because no spot has any different mixture of buttons than another spot.

Does random sampling work if the buttons are not mixed well?

MATERIALS

transparent round container
spoon
one of the six button bags and the model graph which represents this bag (check with your teacher for the graph).
water
graph paper
pill cup

PROCEDURE

1. Empty the button bag into the round container.
2. Fill the container within two inches from the top with water.

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2. Stir the buttons strongly with the spoon.
3. Look down on the surface of the buttons. Look at the buttons through the side of the container. What do you observe?
5. Sample the buttons with the pill cup, carefully pouring the water back into the container.
6. Graph the sample.
7. Compare the graph you just made with the **model graph** or with the graphs you made in the class activities. If you are using the same button bag you used in the class activities. Are they similar? If they are not, why aren't they?
8. Repeat steps 3 and 5 if you aren't sure of your results.
9. Write a short report on your conclusions about **random sampling.** Include all graphs and observations needed to make your report clear.

INVESTIGATION #6

By sampling the people in your school, can you determine about how many people there are with each eye color?

MATERIALS

graph paper
crayons
sample forms
census forms (Ask your teacher to give you these.)

PROCEDURE

1. Decide how many people you will ask about eye color.
2. Decide **where** you will ask these people about their eye color (in the lunchroom, at the drinking fountain, on the playground).
3. Ask your teacher for the "sample of eye color" form.
4. Get your teacher's okay before starting to sample.
5. Take your sample by handing the form to each student you want to sample and having him fill it in.
6. Graph the results when all the forms have been returned.
7. Check your results by conducting a census (a complete count of the eye color of students).
   - Get the form for "census of eye color."
   - Go to each classroom and fill in a census form. (Get the teacher's approval first.)
   - Does this census information agree with the conclusions you got when you took just a sample?
8. If the census results are not similar to the sampling results, try to improve the way you sampled. Did you take enough samples?

INVESTIGATION #7

By sampling the people in your school, can you determine about how many red-haired, blond-haired, brown or black-haired students there are?

MATERIALS

graph paper
crayons
sample forms
census forms (Get these from your teacher.)

PROCEDURE

1. Decide how many people you will ask about hair color.
2. Decide **where** you will ask these people about their hair color (in the lunchroom, at the drinking fountain, on the playground).
3. Ask your teacher for the "sample of hair color" form.
4. Get your teacher's okay before starting to sample.
5. Take your sample by handing the form to each student you want to sample and having him fill it in.
6. Graph the results when all the forms have been returned.
7. Check your results by conducting a census (a complete count of hair color of the students).
   - Get the form for "census of hair color" from your teacher.
   - Go to each classroom and fill in a census form. (Get approval first.)
   - Does this information agree with the conclusions you got when you took just a sample?
8. If the census results are not similar to the sampling, try to improve the way you sampled. Did you take enough samples?

INVESTIGATION #8

Can you tell how many different kinds of plants there are on your lawn by taking samples?

MATERIALS

tape *hoola hoop*
2" square graph paper
plastic sandwich bags

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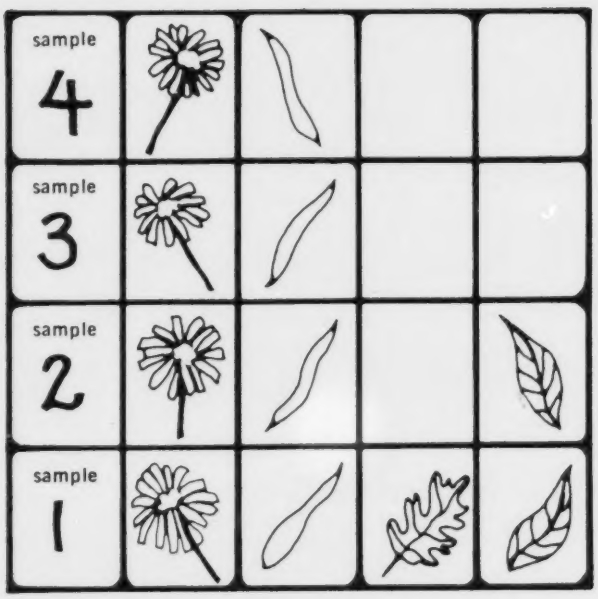
PROCEDURE

1. Select a large area of school lawn.
2. Stand in the middle of this area, close your eyes and lightly toss the hoola hoop.
3. Examine the plants inside the hoola hoop carefully. Pick one plant of each different kind and put it in a sandwich bag. This is your first sample.
4. Decide how many more samples you should take by tossing the hoola hoop. Consider how large the lawn is when you decide how many more times you toss the hoop.
5. Repeat steps 2 and 3 until you have taken as many samples as you think are necessary. Use separate plastic bags for each sample.
6. Ask your teacher for some two inch square graph paper.
7. Put your samples into a pile. Graph the types of plants by taping them on the graph paper.
8. Decide what plant or plants are most abundant on your lawn; which are the least.
9. Write a short report telling how you took your samples and what conclusions you drew.
10. You might repeat this investigation in another area and compare the types of plants.

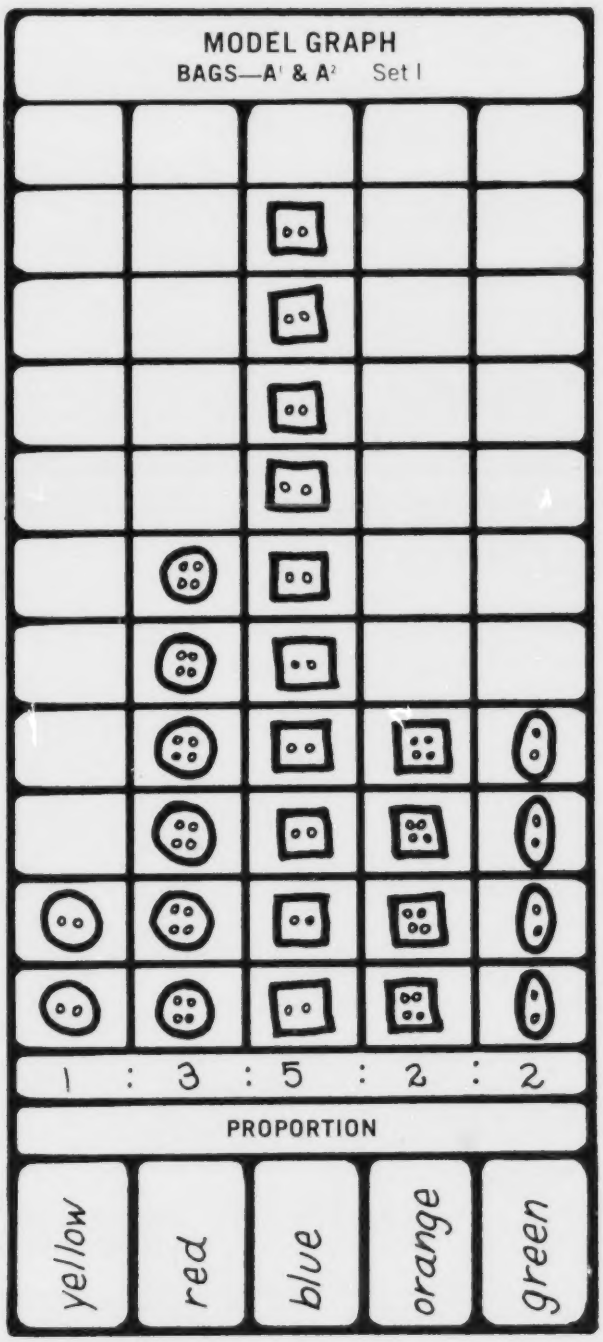


This sample graph was made from four samples. (The hoop was tossed four times.)

II. Model Graphs

Here are instructions for preparing **model graphs** which show the proportions of each type of button in each bag.

A. See the proportions for the first mixture in "Preparing a Button Population." Multiply the proportions by two and make a graph such as the following: (Where ¼ cup is represented by one block.).



Note: The proportions are multiplied by two just to give an overall larger graph that will be a little handier to read.

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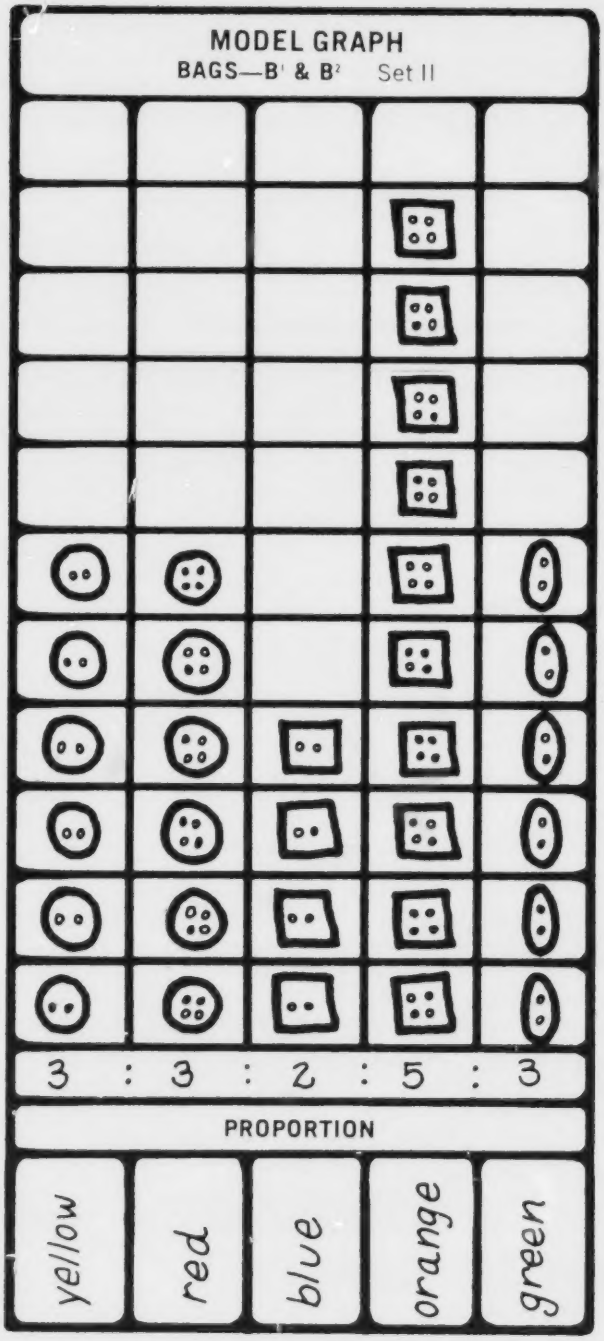
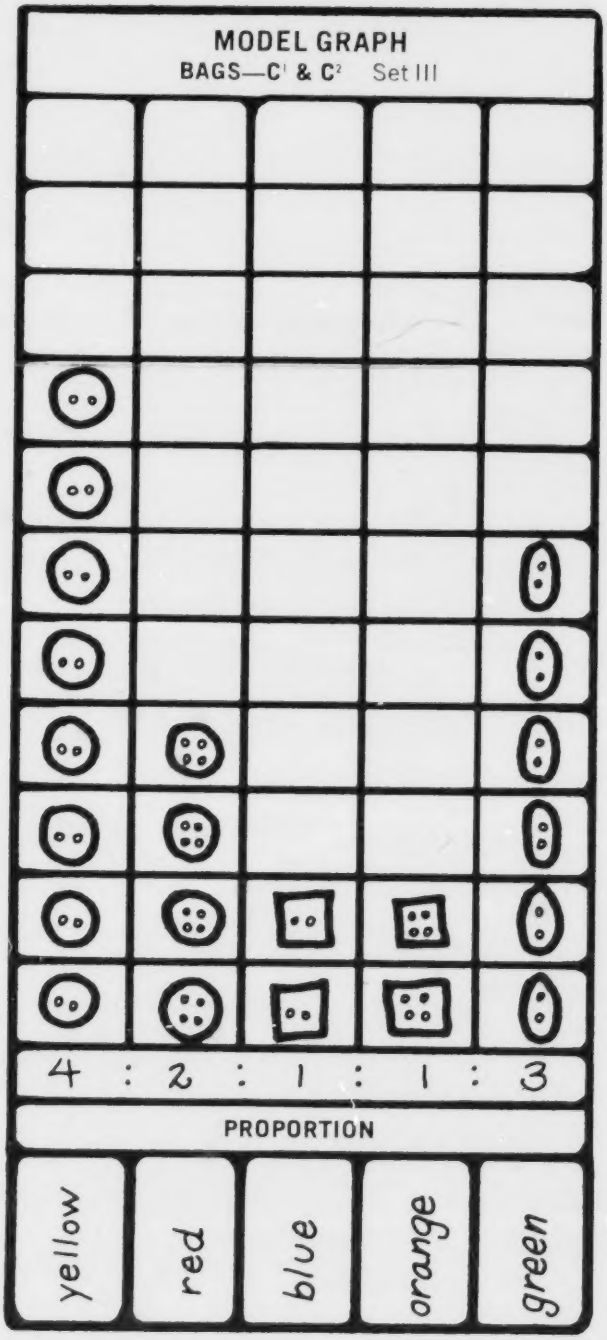
indicate on the back of this model graph, and the two following ones, which button bag each graph represents. This will be helpful in both the class and individual activities if you want to verify whether a particular bag is represented by a particular graph.

B. See the proportions for the second bag in "Preparing a Button Population." Multiply the proportions by two and make a graph such as the following:

C. See the proportions for the third bag in "Preparing a Button Population." Multiply the proportions by two and make a graph such as the following:





SAMPLE OF LEFT-HANDED AND RIGHT-HANDED STUDENTS
(This goes with **Investigation #4**)

Please fill out this form:
If you cannot fill the form out now, fill it in later and return it to room _____

Your Name _____

Grade _____

Put an "x" in the correct blank:

You are right-handed _____

You are left-handed _____

SAMPLE OF EYE COLOR
(This goes with **Investigation #6**)

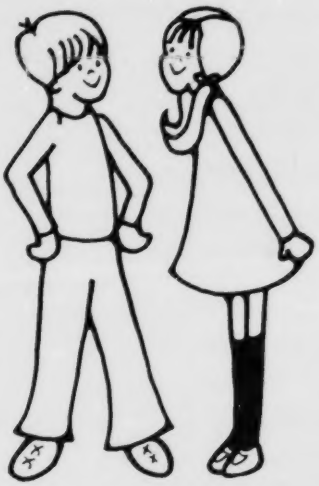
Please fill out this form:
If you cannot fill the form out now, fill it in later and return it to room _____

Your Name _____

Grade _____

Put an "x" in the correct blank:

You are blue-eyed _____
You are green-eyed _____
You are brown-eyed _____
You are black-eyed _____



SAMPLE OF HAIR COLOR
(This goes with **Investigation #7**)

Please fill out this form:
If you cannot fill the form out now, fill it in later and return it to room _____

Your Name _____

Grade _____

Put an "x" in the correct blank:

You have red hair _____
You have brown hair _____
You have black hair _____
You have blond hair _____

CENSUS OF LEFT-HANDED AND RIGHT-HANDED STUDENTS

Grade _____

Classroom number _____

Number of right-handed students _____

Number of left-handed students _____

CENSUS OF EYE COLOR

Grade _____

Classroom number _____

Number of blue-eyed students _____

Number of green-eyed students _____

Number of brown-eyed students _____

Number of black-eyed students _____

CENSUS OF HAIR COLOR

Grade _____

Classroom number _____

Number of red-haired students _____

Number of brown-haired students _____

Number of black-haired students _____

Number of blond-haired students _____

THE ENVIRONMENTAL UNITS

Below is a list of the twenty-four titles in the Environmental Discovery Series. Next to the titles, we have suggested the grades for which each is most appropriate. We emphasize that these are suggested grade levels. The teacher is encouraged to adapt the activities to a wide range of grade levels and subject areas depending upon the interests and abilities of the students.

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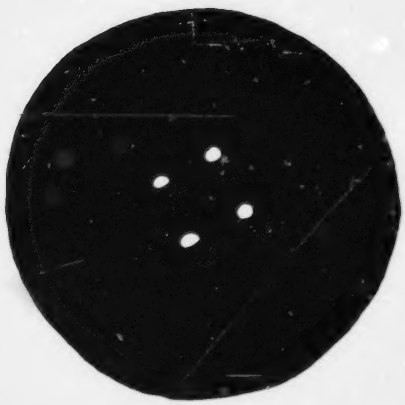

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